TEXAS J. SCI. 56(4):427-440 NOVEMBER, 2004

FEEDING HABITS OF SONGBIRDS IN EAST TEXAS CLEARCUTS DURING WINTER

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Abstract.—This east Texas study was undertaken to determine the importance of seeds of forbs, grasses, and woody shrubs to songbirds wintering in young pine plantations which had been established utilizing the clearcut regeneration system. The feeding habits and preferences of four species of songbirds, northern cardinals (*Cardinalis cardinalis*), song sparrows (*Melospiza melodia*), dark-eyed juncos (*Junco hyemalis*), and white-throated sparrows (*Zonotrichia albicollis*) were examined from November to February of 1980-81, 1981-82, and 1982-83. Differences in consumption percentages were compared among bird species using *ANOVA* and Duncan's multiple range tests. Paired *t*-tests were used to compare seeds consumed to seeds available by bird species. Differences ($P \leq 0.05$) existed among bird species in consumption percentages of seeds of various genera. Northern cardinals selected seeds of *Callicarpa*, *Croton*, *Datura*, and *Galactia*. Song sparrows used seeds of *Ambrosia*, *Panicum*, and *Seteria* in excess of abundance. Dark-eyed juncos also selected *Ambrosia* as well as *Eragrostis* and *Parietaria* over seeds of other genera. *Ambrosia*, *Parietaria*, *Aristida*, and *Viola* were preferred by white-throated sparrows.

Of the 4.7 million ha of commercial forest land in East Texas, 1.8 million are owned by forest industry (McWilliams & Lord 1988). Most such lands are intensively managed for pine on a short rotation (< 50 years), evenage basis. A common practice on industrial forest lands is to clearcut the marketable timber at rotation age, prepare the site, and plant pine seedlings. After site preparation, growth and seed production of grasses and forbs are stimulated by decreased competition for nutrients, water, and sunlight. In the winter months, seeds of such plants are a valuable food source for birds.

Few data exist on food habits and preferences or food availability to free-ranging songbirds wintering in young southern pine plantations. Therefore, the objectives of this study were to analyze winter foods of northern cardinals (*Cardinalis cardinalis*), song sparrows (*Melospiza melodia*), dark-eyed juncos (*Junco hyemalis*), and white-throated sparrows (*Zonotrichia albicollis*) collected on areas which had been recently clearcut, site prepared, and planted to pine seedlings, and to

determine if these species were selecting seeds of certain genera or if their feeding habits were dependent on seed availability.

METHODS

Two study areas in the Pineywoods Ecological Region of east Texas were selected, one in Nacogdoches County and another in Angelina County. Although the areas were in different counties, they were less than 20 km apart. Both areas had been clearcut, then residual vegetation sheared and along with debris, raked into long piles called windrows. The windrows were burned on the Angelina County study area. Both areas were planted with one-year-old pine seedlings during the study period. With one exception, soils on both study areas were well-drained fine sandy loams or loamy sands. A small part of the Angelina County study area was nearly level, thus poorly drained (Worthington 1984).

Northern cardinals, dark-eyed juncos, and song sparrows were collected on the study areas during November, December, January, and February of 1980-81, 1981-82, and 1982-83; white-throated sparrows were collected in 1982-83 only. Efforts were made to collect five individuals of each species on each study area per month. All birds were collected in the morning. Each collected bird was immediately weighed to the nearest 0.5 grams. The digestive tract (esophagus, proventriculus, gizzard) was then removed and injected with 1 CC of 10% formalin (Dillery 1965) to stop the digestive process. The tract was placed in a self-sealing plastic bag along with an identification number. The location where the bird was first observed was marked with plastic flagging bearing the bird's identification number. Upon returning from the field, each digestive tract was frozen and stored.

In the laboratory, the contents of each digestive tract were dried at 38°C for 48 hours, then weighed to the nearest 0.0001 g. Digestive tract contents were then separated into four groups, namely plant seeds, insect parts, grit, or unidentified material. Seeds were then separated to genus using keys (Musil 1963; Landers & Johnson 1976) and a U.S. Forest Service reference seed collection. Seeds not identified were kept separate, labeled unknown, and assigned a number. Many of these unknown seeds were later identified. All food materials were then redried at 38°C for 48 hours and weighed to the nearest 0.0001 g.

Seeds on the ground, presumably available to the collected birds,

were sampled during the 1981-82 and 1982-83 study periods, usually the same day the birds were collected. Seeds were sampled on five 10 cm radius subplots in the area where each bird was first observed. The first subplot was where the bird was originally observed and the others were in each cardinal direction, 2 m from the first subplot. Food materials were collected using a hand-held power vacuum. Seeds on standing vegetation directly above the subplots also were collected.

In the laboratory, availability samples were frozen for 48 hours to kill insects, then coarse debris was removed. The remaining material was passed through a series of sieves to sort seeds by size class and remove fine debris. A binocular dissecting scope was used when separating seeds from fine debris. The seeds were sorted, dried, and weighed in the same manner as were seeds in the digestive tracts of the birds. The five subplot samples were combined to form a single availability sample for analyses.

For each bird species, the number of individuals that consumed each seed genus was determined by study area. Each value was then divided by the total number of birds of that species to obtain frequency of occurrence. Differences in frequencies of occurrence were tested among bird species by study area using two-by-four Chi-square tests.

Due to differences in body weights and total digestive tract content weights among the four bird species (Worthington 1984:61), actual weights of seed genera consumed were not compared among the bird species. Instead, weights of all identified and unidentified seeds in each bird's digestive tract were summed and the weight of each genus was converted to a percent of that sum. These values reflected consumption percentages and were compared among the four bird species. Seeds available to the birds were evaluated similarly. The conversion of actual weights to percentages also allowed for comparisons between consumed and available seeds. Insect parts, grit, and unidentified material were not compared.

Differences among bird species in seed consumption percentages were tested using *ANOVA* with Duncan's multiple range tests. Differences in seed availability percentages were tested in the same manner. For each genus, paired *t*-tests were used to compare percentages of seeds consumed to percentages of seeds available by bird species and study

area. As seed availability data were not collected in 1980-81, seed consumption data from that year were not used when comparing seeds consumed to those available.

In order for a seed genus to be included in the statistical comparisons of digestive tracts, it had to average at least 2% of consumed seeds, by weight, for at least one bird species. To be included in comparisons of availability data, a genus had to comprise at least 4% of the available seeds, by weight, for at least one bird species. Throughout the study, the null hypothesis used was that of no difference among groups being tested. The rejection level was set at 0.05 for all tests.

RESULTS

Ninety-five northern cardinals, 59 song sparrows, and 86 dark-eyed juncos were collected during the three winters; 45 white-throated sparrows were collected in the winter of 1982-83. Unidentified material comprised 64.2, 67.0, 65.7, and 72.9% of weights of digestive tract contents of northern cardinals, song sparrows, dark-eyed juncos, and white-throated sparrows, respectively; identifiable seeds made up 23.5, 16.5, 18.2, and 14.3% of digestive tract content weights of the four species, respectively. With one exception, small amounts of greenery, insects, and grit made up the remainder; one northern cardinal had consumed a ground skink *(Scincella lateralis).* Most unidentified material was in the gizzard. It was assumed that proportions of unidentifiable material in that organ were the same as those identifiable (West 1973).

Seeds consumed.—Seeds of 38 genera were identified and recorded in digestive tracts of the birds (Worthington 1984:64-74). Eight groups of seeds could not be identified, but only one was consumed in greater than trace (i.e., < 1.0%) quantities. With one exception, seeds of all identifiable genera recorded in digestive tracts were also recorded in availability samples; no *Datura* seeds were recorded in availability samples.

In Nacogdoches County, differences existed among bird species in frequencies of occurrence of seeds of 10 genera (Table 1). A higher proportion of the northern cardinal digestive tracts contained seeds of *Callicarpa, Croton,* and *Datura* than did those of the other three bird species. Conversely, *Ambrosia* occurred in a lower proportion of northern cardinals than in the other three species. *Eragrostis* and

Table 1. Numbers of birds and frequency of occurrence of seeds in digestive tracts of northern cardinals (NOCA), song sparrows (SOSP), dark-eyed juncos (DEJU), and white-throated sparrows (WTSP, 1982-1983 only) collected in eastern Texas during winter 1980-81, 1981-82, and 1982-83. Within a row, a different letter indicates different frequencies of occurrence among bird species at the 0.05 level.

Seed genera	NOCA		SOSP		DEJU		WTSP		X^2
	n	%	*n*	%	*n*	%	*n*	%	*P*
NACOGDOCHES COUNTY									
Amaranthus	7	12.3a	2	18.2a	24	51.1b	5	23.8a	<0.001
Ambrosia	4	7.0a	5	45.5b	26	55.3b	15	71.4b	<0.001
Callicarpa	23	40.4a	1	9.1b	0	0.0b	2	9.5b	<0.001
Carex	4	7.0	1	9.1	0	0.0	0	0.0	0.153
Croton	28	49.1a	0	0.0b	0	0.0b	1	4.8b	<0.001
Cyperus	2	3.5a	3	27.3b	8	17.0b	0	0.0a	0.008
Datura	29	50.1a	2	18.2b	3	6.4b	0	0.0b	<0.001
Digitaria	12	21.1	4	36.4	13	27.7	1	4.8	0.120
Eragrostis	0	0.0a	5	45.5c	12	25.5b	0	0.0a	<0.001
Panicum	2	3.5a	6	54.6c	11	23.4b	0	0.0a	<0.001
Parietaria	0	0.0a	1	9.1a	20	42.6b	12	57.1b	<0.001
Paspalum	4	7.0	2	18.2	2	4.3	0	0.0	<0.201
Phytolacca	20	35.1a	2	18.2ab	3	6.4b	0	0.0b	<0.001
Rudbeckia	0	0.0	0	0.0	2	4.3	0	0.0	<0.284
Sample size	57		11		47		21		
ANGELINA COUNTY									
Amaranthus	0	0.0a	2	4.2a	12	30.8b	1	4.5a	<0.001
Ambrosia	4	10.5a	15	31.3b	17	43.6b	12	50.0b	0.003
Callicarpa	14	36.8a	0	0.0b	0	0.0b	0	0.0b	<0.0001
Carex	12	31.6a	16	33.3a	1	2.6b	4	16.7b	0.002
Croton	13	34.2a	1	2.1b	1	2.6b	0	0.0b	<0.001
Cyperus	1	2.6a	8	16.7ab	10	25.6b	6	25.0b	0.031
Datura	15	39.5a	3	6.3b	0	0.0b	0	0.0b	<0.001
Digitaria	0	0.0a	7	14.6b	7	18.0b	1	4.5ab	0.029
Eragrostis	0	0.0	3	6.3	4	10.3	1	4.5	0.252
Panicum	1	2.6a	38	79.2b	31	79.5b	8	33.3c	<0.001
Parietaria	0	0.0	1	2.1	1	2.6	0	0.0	0.693
Paspalum	2	5.3a	2	4.2a	8	20.5b	0	0.0a	0.008
Phytolacca	0	0.0	4	8.3	2	5.1	0	0.0	0.172
Rudbeckia	0	0.0a	1	2.1a	10	25.6b	0	0.0a	<0.001
Sample size	38		48		39		24		

Panicum seeds were found in greater proportions of song sparrow digestive tracts than in those of the other three species and in more dark-eyed junco tracts than in northern cardinal or white-throated sparrow tracts. *Amaranthus* occurred in a higher proportion of dark-eyed juncos than in the other three bird species. A majority of white-throated sparrows consumed *Ambrosia* and *Parietaria*.

In Angelina County, *Callicarpa*, *Croton*, and *Datura* were recorded in higher proportions of northern cardinal digestive tracts than in those of the other three species (Table 1). Conversely, *Ambrosia* and *Panicum* were found in lower proportions of northern cardinal digestive tracts than in digestive tracts of the other species. *Ambrosia* was found in half of white-throated sparrows, and *Panicum* occurred in almost 80% of the song sparrows and dark-eyed juncos. Finally, higher proportions of dark-eyed juncos than the other species consumed *Amaranthus*, *Paspalum*, and *Rudbeckia*.

Seeds of 23 genera comprised at least 2% of the total weight of seeds in the digestive tracts of one or more bird species (Worthington 1984:64-74). Percent consumption of 12 of these genera differed among bird species (Table 2). Combined, *Croton* and *Datura* comprised approximately 64 and 43% of the weight of seeds in the digestive tracts of northern cardinals collected on the Nacogdoches County and Angelina County study areas, respectively. On both study areas, these combined percentages were higher than those of the other three bird species (Table 2). Song sparrows and dark-eyed juncos consumed relatively large quantities of *Ambrosia*, *Digitaria*, and *Panicum* on both study areas. Percent consumption of these genera by song sparrows and dark-eyed juncos were generally higher than for northern cardinals and white-throated sparrows, except for *Ambrosia* which made up a higher percentage of the digestive tract contents of white-throated sparrows than of the other species (Table 2). On the Nacogdoches County study area, white-throated sparrows also consumed relatively more *Parietaria* than did the other species.

Seeds available.—Eighty-two genera of seeds were collected on the two study areas, 72 on the Nacogdoches County study area and 61 on the Angelina County study area (Worthington 1984:62-63). Fifty-one genera were common to both areas; 21 and 10 were exclusive to Nacogdoches County and Angelina County, respectively. However,

Table 2. Weights (in percent) of seeds recorded in digestive tracts of northern cardinals (NOCA), song sparrows (SOSP), dark-eyed juncos (DEJU), and white-throated sparrows (WTSP, 1982-1983 only) collected in eastern Texas during winter 1980-81, 1981-82, and 1982-83. Only genera for which there were significant differences among bird species are shown. Within a row by study area, a different letter denotes different proportions among bird species at the 0.05 level.

	Nacogdoches County				Angelina County			
Seed genera	NOCA	SOSP	DEJU	WTSP	NOCA	SOSP	DEJU	WTSP
Amaranthus	0.39a	2.07ab	26.46c	13.30b	0.00a	1.43a	10.50b	3.72ab
Ambrosia	0.35a	24.94b	26.42b	49.05c	4.18a	11.64a	9.98a	39.41b
Callicarpa	8.08a	4.55ab	0.00b	1.99b	17.21a	0.00b	0.00b	0.00b
Carex	1.28	0.79	0.00	0.00	5.58ab	10.18b	1.87a	4.48ab
Croton	34.40a	0.00b	0.00b	2.94b	21.00a	1.50a	0.93b	0.00b
Datura	30.04a	2.29b	0.65b	0.00b	22.50a	0.44b	0.00b	0.00b
Digitaria	0.30a	15.24b	8.12b	1.14a	0.00a	0.92ab	3.31b	0.80ab
Eragrostis	0.00a	7.01b	5.50b	0.00a	0.00	1.25	0.74	0.11
Panicum	0.07a	6.50b	3.84b	0.00a	0.27a	42.74b	34.81b	13.91a
Parietaria	0.00a	8.54ab	15.34b	28.05c	0.00	1.35	0.55	0.00
Paspalum	1.99	6.79	1.91	0.00	0.25a	1.07a	7.10b	0.00a
Phytolacca	11.53a	10.67a	1.53b	0.00b	0.00	3.28	1.40	0.00
Total (%)	88.44	89.39	89.77	96.47	71.26	75.80	71.19	62.43
Sample size	57	11	47	21	38	48	39	24
							0.55	0.00

only 16 genera each contributed a minimum of 4% of the seeds available to at least one bird species.

The genera of frequently occurring seeds included *Andropogon, Digitaria, Panicum, Phytolacca, Rhus, Solidago,* and *Uniola.* On the Nacogdoches County study area, there were differences among bird species in seed availability frequencies of five commonly occurring genera (Worthington 1984:34). However, only *Ambrosia, Digitaria,* and *Eragrostis* comprised at least 2% of the weight of seeds consumed. *Ambrosia* occurred more frequently in white-throated sparrow and song sparrow food availability samples than in those of northern cardinals, and *Digitaria* was recorded in higher percentages of song sparrow and dark-eyed junco than white-throated sparrow food availability samples. *Eragrostis* was found in a higher percentage of song sparrow food availability samples than in those of the other species (Worthington 1984:34). For the Angelina County study area, frequencies of only two seed genera differed among food availability samples (Worthington 1984:35). Neither of these, *Eupatorium* and *Heterotheca*, could be considered important food items to the collected birds.

Table 3. Weights (in percent) of seeds available to northern cardinals (NOCA), song sparrows (SOSP), dark-eyed juncos (DEJU), and white-throated sparrows (WTSP, 1982-1983 only) collected in eastern Texas during winter 1981-82 and 1982-83. Genera shown are those for which there were differences in percent availability and/or percent consumption. Within a row by study area, a different letter denotes different proportions at the 0.05 level.

	Nacogdoches County				Angelina County			
Seed genera	NOCA	SOSP	DEJU	WTSP	NOCA	SOSP	DEJU	WTSP
Amaranthus	8.78a	4.54a	25.92c	17.28b	0.56	3.11	3.40	1.64
Ambrosia	0.89	3.13	4.36	3.51	0.14a	5.79ab	8.25b	1.31ab
Callicarpa	7.68	6.21	3.74	1.81	2.30	0.10	0.00	0.79
Carex	0.02	0.00	0.03	0.00	0.09	4.27	0.47	3.32
Croton	4.95	0.49	4.74	1.65	0.30	0.02	0.24	0.51
Digitaria	1.13a	14.23b	3.41a	0.31a	0.00a	0.34a	1.96b	0.49a
Eragrostis	0.15	0.75	0.26	0.00	1.09	0.71	0.13	3.08
Eupatorium	1.69	3.25	0.52	2.06	2.33	7.90	1.88	3.89
Galactia	0.28a	5.94b	1.25a	0.65a	0.00	0.17	0.00	0.00
Heterotheca	0.95	5.01	1.28	3.18	7.72	2.29	6.96	12.83
Panicum	5.18	7.74	2.63	0.44	10.54a	25.99b	26.00b	11.02a
Parietaria	0.00	0.21	0.10	0.35	0.00	0.00	0.00	0.00
Paspalum	0.74	0.93	0.06	0.17	1.57	0.92	0.00	1.28
Phytolacca	14.16a	5.33a	10.30a	30.11b	1.13	2.17	2.43	0.18
Rhus	29.26	33.77	21.88	28.93	21.75a	5.14b	15.94ab	24.42a
Uniola	0.43	0.00	0.63	0.64	7.28	9.42	9.56	8.26
Sample size	42	7	37	21	29	39	24	24

There were some differences in weights (in percent) of seeds available to the bird species in each county (Table 3). In Nacogdoches County, there were differences among species for *Amaranthus, Digitaria, Galactia*, and *Phytolacca*. There was a higher proportion of *Amaranthus* seeds in dark-eyed junco availability samples than in those of the other species, and a higher proportion in white-throated sparrow samples than in northern cardinal or song sparrow samples. Song sparrow availability samples contained higher proportions of *Digitaria* and *Galactia* seeds than did samples for the other species, and *Phytolacca* seeds ranked higher in white-throated sparrow samples than in samples for the other species (Table 3).

In Angelina County, there were differences in seed availability percentages of *Ambrosia, Digitaria, Panicum*, and *Rhus* among bird species. Both *Ambrosia* and *Panicum* seeds were less available to northern cardinals than to the other species. *Digitaria* seeds ranked higher for dark-eyed juncos than for the other species, but made up less

than 2% of the food available to that species. *Rhus,* which comprised large proportions of the seeds available on both study areas (Table 3), was not an important food source to any species.

Seeds selected.—Callicarpa, Croton, Datura, Galactia, and *Phytolacca* comprised 90% of the seeds consumed by northern cardinals in Nacogdoches County during the winters of 1981-82 and 1982-83 (Table 4); *Croton, Datura,* and *Galactia* were consumed in excess of availability. The same was true of *Callicarpa* and *Croton* in Angelina County. *Phytolacca* availability exceeded consumption in Nacogdoches County but was not recorded in any Angelina County digestive tracts (Table 4).

Only seven song sparrows were collected in Nacogdoches County, thus statistical comparisons are weak at best. However, almost 35% of the seeds identified in the digestive tracts of those birds were *Ambrosia.* Seeds of that genus, *Carex, Panicum,* and *Seteria* were dominant in Angelina County song sparrows. Consumption percentages of the two latter genera were greater than availability percentages (Table 4).

For darked-eyed juncos from Nacogdoches County, consumption of *Ambrosia, Eragrostis,* and *Parietaria* exceeded availability. *Amaranthus,* which was readily available on that study area, comprised slightly over 25% of the seeds consumed. In Angelina County, seeds of *Amaranthus, Ambrosia, Digitaria,* and *Panicum* comprised almost 70% of identifiable seeds in dark-eyed junco digestive tracts; consumption and availability percentages of these genera were similar (Table 4).

White-throated sparrows were collected only in 1982-83. In both counties, *Ambrosia* compromised the largest proportion of identifiable seeds. Consumption of that genus and *Parietaria* exceeded availability in Nacogdoches County. In Angelina County, *Ambrosia, Aristida,* and *Viola* demonstrated similar trends. *Amaranthus* in Nacogdoches County and *Cyperus* and *Panicum* in Angelina County were important food items for which consumption and availability percentages did not differ (Table 4). *Rhus* seeds were recorded in two white-throated sparrows in Angelina County.

DISCUSSION

Although identifiable seeds comprised relatively small proportions of digestive tracts, this study provided strong evidence that northern cardinals, song sparrows, dark-eyed juncos, and white-throated sparrows

Table 4. Comparisons of percent seed availability and percent seed consumption for northern cardinals, song sparrows, dark-eyed juncos, and white-throated sparrows in eastern Texas during winter 1981-82 and 1982-83. Paired *t*-tests values also are shown.

Seed genera	Nacogdoches County			Angelina County		
	Pct. Avail.	Pct. Cons	*P* - value	Pct. Avail.	Pct. Cons.	*P* - value
Northern cardinals			$n = 42$			$n = 29$
Amaranthus	8.78	0.19	0.006	0.57	0.00	0.194
Callicarpa	7.68	9.22	0.481	2.63	19.09	0.030
Carex	0.02	1.91	0.230	1.03	6.36	0.162
Croton	4.95	46.01	<0.001	0.31	26.81	0.001
Datura	0.00	24.35	<0.001	0.00	6.66	0.113
Galactia	0.28	5.16	0.041	0.00	0.00	1.000
Heterotheca	0.95	0.01	0.049	7.69	0.00	0.047
Myrica	2.17	0.00	0.274	5.16	0.00	0.153
Panicum	5.18	0.03	0.018	10.77	0.33	0.024
Phytolacca	14.16	5.31	0.016	1.15	0.00	0.179
Rhus	29.26	0.00	<0.001	22.92	0.00	0.002
Uniola	0.43	0.00	0.310	7.91	3.66	0.381
Song sparrows			$n = 7$			$n = 39$
Amaranthus	4.54	0.87	0.252	3.11	1.77	0.615
Ambrosia	3.28	34.91	0.053	5.79	11.41	0.227
Carex	0.00	1.23	0.356	4.27	8.47	0.265
Digitaria	14.23	19.29	0.734	0.34	0.49	0.880
Eupatorium	3.25	0.00	0.352	7.90	0.00	0.001
Panicum	7.74	2.15	0.343	25.99	44.48	0.010
Phytolacca	5.33	0.00	0.120	2.17	2.60	0.894
Rhus	33.74	0.00	0.071	5.14	0.00	0.042
Seteria	0.00	0.00	1.000	0.00	6.35	0.044
Uniola	0.00	0.00	1.000	9.42	0.03	0.004
Dark-eyed juncos			$n = 37$			$n = 24$
Amaranthus	26.10	25.63	0.912	3.40	11.27	0.110
Ambrosia	4.33	29.60	<0.001	8.25	13.88	0.454
Digitaria	3.37	5.93	0.337	1.96	5.25	0.312
Eragrostis	0.27	5.62	0.044	0.13	1.12	0.169
Heterotheca	1.29	0.00	0.049	6.96	0.00	0.035
Panicum	2.63	3.37	0.641	25.95	39.23	0.166
Parietaria	0.10	19.49	<0.001	0.00	0.89	0.094
Phytolacca	10.20	0.30	<0.001	2.43	2.28	0.658
Rhus	21.75	0.00	<0.001	15.91	0.00	0.025
Uniola	0.63	2.28	0.135	9.54	2.22	0.117
White-throated sparrows*			$n = 21$			$n = 24$
Amaranthus	17.28	13.30	0.645	1.64	3.72	0.637
Ambrosia	3.51	49.05	<0.001	1.31	39.41	0.001
Aristida	0.00	0.00	1.000	0.00	11.99	0.041
Cyperus	0.13	0.00	0.892	3.20	8.88	0.409
Eupatorium	2.06	0.00	0.134	3.89	0.00	0.106
Heterotheca	3.18	0.14	0.181	12.83	0.00	0.016
Panicum	0.44	0.00	0.014	11.02	13.91	0.948
Parietaria	0.35	28.05	0.002	0.00	0.00	1.000
Phytolacca	30.11	0.00	<0.001	0.18	0.00	0.319
Rhus	28.93	0.00	0.001	24.42	1.28	0.008
Uniola	0.64	0.00	0.329	8.26	0.40	0.057
Viola	0.00	2.35	0.126	0.00	6.28	0.020

* Collected in winter 1982-83 only.

selected seeds of some genera over those of others. Korschgen (1980) noted that if a food item occurred in high numbers of individuals and in high volume within the individuals, the food was of high quality or preference. In this study, three or four genera met these criteria for each bird species. For most of these genera, consumption exceeded availability.

Seeds utilized by northern cardinals were very different from those used by the other species. With study areas combined, *Callicarpa, Croton,* and *Datura* comprised approximately 69% of the seeds identified in northern cardinal digestive tracts. These genera made up only trace proportions in digestive tracts of the other bird species. The importance of *Croton* and *Callicarpa* to northern cardinals is well-documented (Martin et al. 1951; Halkin & Linville 1999). *Carex, Rhus, Setaria,* and *Panicum* have also been classified as important to northern cardinals (Halkin & Linville 1999). Although seeds of these genera were collected on the study areas, they made up minor portions of northern cardinal diets, and no *Rhus* was recorded in any northern cardinal. No mention of northern cardinals consuming *Datura* was found in the literature. Reasons for the absence of *Datura* seeds in availability samples are unknown; *Datura* plants were present on both study areas.

Although there were similarities in diets of song sparrows, dark-eyed juncos, and white-throated sparrows, the relative rank of the important genera varied among species. For song sparrows, *Panicum* made up 38% of identifiable seeds; *Ambrosia* (15%) ranked second and *Carex* (7%) third. Neither Martin et al. (1951) nor Arcese et al. (2002) listed *Panicum* as an important food source for song sparrows. Results of this study contradict those findings, and it is possible that the low number of song sparrows collected in Nacogdoches County was due to the lack of *Panicum. Ambrosia* seeds are an important winter food item for song sparrows (Martin et al. 1951), as are those of *Amaranthus, Digitaria,* and *Setaria* (Arcese et al. 2002). In this study, seeds of these three genera comprised relatively minor proportions of song sparrows diets.

In dark-eyed junco digestive tracts, *Ambrosia* (23%), *Amaranthus* (20%), *Panicum* (18%), and *Parietaria* (12%) made up almost three-fourths of the identifiable seeds. Judd (1901) and Nolan et al. (2002) noted the importance of *Ambrosia* and *Amaranthus* to dark-eyed juncos.

Martin et al. (1951) also found seeds of *Ambrosia* and various grasses to be important food items for the species.

White-throated sparrows were abundant on both study areas during winter 1982-83. With data from study areas pooled, *Ambrosia,* (43%) comprised a higher proportion of that species diet than did any genera in diets of the other species. Falls & Kopachena (1994) noted the importance of *Ambrosia* to white-throated sparrows. However, they also stated that fruits of *Rhus* were important to the species. During this study, numerous white-throated sparrows were observed foraging in *Rhus*, and it was assumed that they were eating *Rhus* fruit. Several of those were birds were collected, yet *Rhus* seeds comprised a very minor proportion of the diet. Halls (1977) noted that birds cannot sustain weight on a heavy diet of *Rhus* and that it is normally eaten with other foods. The very small amount of *Rhus* consumed by birds collected in this study support Halls' comments and indicate that birds observed foraging in *Rhus* were either seeking other food items or were consuming minute quantities of that genus.

CONCLUSIONS

In this study, each bird species consumed seeds of several genera in excess of availability. Also, availability percentages exceeded consumption percentages for some genera and did not differ for others. Although seeds of all genera were available to each species, the differences among species may have been due to differences in habitat selection within the clearcuts. Virtually all northern cardinals were first observed in or adjacent to the relatively dense vegetation of the windrows or small riparian zones which were present on both study areas. Song sparrows were usually in dense grassy areas between rows of planted pine seedlings. Dark-eyed juncos were in similar areas, but at higher elevations where ground cover was less dense. White-throated sparrows were collected in areas similar to those of northern cardinals. These results demonstrate that when properly administered, the clearcutting method of regeneration creates excellent habitat for ground-foraging, seed-eating birds which winter in the southern United States. This method creates openings in the forest and, combined with site preparation techniques that scarify both the soil and dormant seeds, promotes the establishment of seed-bearing forbs and grasses.

ACKNOWLEDGMENTS

We appreciate the field assistance of Steve Best and Nolan Smith and the laboratory assistance of Tracy Havins, Kathleen Kroll, and Karen Hoza-Wilson. We are indebted to John Roese for much of the statistical analyses. Rhonda Barnwell, Crystal Linebarger, and Ashley Sample provided manuscript preparation. This project was funded by the U.S. Forest Service, Southern Experiment Station, and the Arthur Temple College of Forestry at Stephen F. Austin State University.

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